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Revision of the Western Palaearctic species of *Orthocentrus* Gravenhorst, 1829 (Hymenoptera, Ichneumonidae, Orthocentrinae): species with ivory/yellow marks on the vertex

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Abstract

In the first of a series of papers revising the poorly-studied Darwin wasp genus *Orthocentrus* Gravenhorst, 1829, in the Western Palaearctic, here we revise species with yellow or ivory marks on the vertex. Several new country records are provided: *O. bilineator* Aubert, 1959 and *O. castellanus* Ceballos, 1963 from Italy; *O. hirsutor* Aubert, 1969 from Italy, Sweden and Ukraine; and *O. orbitator* Aubert, 1963 from Israel, Italy, Turkey, and Ukraine. One species, *O. mirabilis* Varga & Di Giovanni, **sp. nov.**, is described as new from Belgium, Italy, Poland, Sweden, and Ukraine. An identification key, diagnoses and illustrations to all the studied species are provided.

Keywords

Biodiversity, Darwin wasps, key, new records, new species, *Orthocentrus* group, parasitoids

Introduction

The Darwin wasp subfamily Orthocentrinae comprises many of the smallest and most overlooked parasitoids of the family Ichneumonidae. The subfamily includes about 500 described species (Yu et al. 2016), although this is only a tiny part of the true diversity of

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the group (e.g., Veijalainen et al. 2012). Their small size and the little attention they have received make the orthocentrines one of the most taxonomically difficult group of Ichneumonidae. The current and most widely accepted concept of Orthocentrinae divides the subfamily into two genus groups: the *Helictes* group and the *Orthocentrus* group (Wahl and Gauld 1998; Bennet et al. 2019). The *Orthocentrus* group comprises a distinctive, monophyletic lineage within the subfamily, whose members can be recognized in having the clypeus fused with or weakly divided from the face and a long, cylindrical scape. However, the relationships inside the group still remain unresolved (Broad 2010; Varga 2024a, 2024b).

The genus *Orthocentrus* Gravenhorst, 1829 is probably the most easily recognizable among the group, having a rounded apical margin of the clypeus that hides the labrum. However, a slightly truncate clypeus in some species, as well as different structure of the mandibles and some other characters call the monophyly of the genus into question (Broad 2010; Veijalainen et al. 2014). *Orthocentrus* is the best documented genus of the group, with more than 150 described species already (Veijalainen et al. 2014; Yu et al. 2016; Humala 2019; Humala et al. 2020; Watanabe et al. 2024). Recently, studies have been carried out in the Amazonian forests (Veijalainen et al. 2014; Zwakhals and Diller 2015), Mexico (Humala 2019) and South Korea (Humala et al. 2020), while the Afrotropical and Oriental regions – with altogether only 16 known species – remain almost completely untouched (Yu et al. 2016).

Most of the European *Orthocentrus* species were described by Swedish entomologists at the end of the 19th Century (Holmgren 1858; Thomson 1897). Since then, only Aubert (1978) tried to sort out the confusion over the interpretation of some species, revising the genus in Europe and describing several new species from southern Europe. Unfortunately, this paper was still far from giving a comprehensive view of the diversity of *Orthocentrus* in the Western Palaearctic, as many undescribed species were overlooked by the author while others lack detailed descriptions that would allow proper species identification without comparison material.

The genus *Orthocentrus* currently contains 35 species in Europe (Yu et al. 2016). Among them (Varga, in prep.), about a quarter of species have uncertain taxonomic status (incertae sedis) or belong to other genera (new combinations). The rest of the species, together with up to fifteen undescribed ones, can be preliminarily placed in five morphological units, more or less corresponding to the groups proposed by Veijalainen et al. (2014) and Humala (2019). The groupings proposed by Veijalainen et al. (2014) were based on both morphological and molecular data and applied to the Neotropical species, resulting in five species groups: *O. insularis* species-group, *O. maculae* species-group, *O. shieldsi* species-group, *O. wahlbergi* species-group, and *O. zebra* species-group. Later, Humala (2019) proposed two additional groups based on species described from Mexico: *O. montanus* species-group and *O. ungularis* species-group.

Most of the Western Palaearctic species belong to the following:

1. *Orthocentrus insularis* species-group. In Europe, only *O. longicornis* Holmgren, 1858 can tentatively be placed in this group. This species is characterized by the rugose anterior tergites and very long and slender antenna, which is typical for the members of the group. However, the presence of distinct notauli is not consistent with Neotropical species.

2. *Orthocentrus maculae* species-group. Contains few species which are characterized by the anteriorly distinct notauli, aciculate face, elongate basal flagellomeres, strongly transverse head in dorsal view (e.g. Fig. 1B–D), and open areolet.

3. *Orthocentrus montanus* species-group. Species of this group differ from the previous unit mainly by the closed areolet, which is often petiolate (abscissa of Rs between 2rs-m and 3rs-m absent or extremely short). It contains many Western Palaearctic species, including four revised in this study: *O. canariensis*, *O. castellanus*, *O. mirabilis* sp. nov., and *O. orbitator*. However, some species, such as *O. sannio* Holmgren, 1858, show variability in the structure of the areolet (3rs-m can be absent or present), questioning the separation between the *O. montanus* and *O. maculae* species-groups.

4. *Orthocentrus shieldsi* species-group. This is probably the most easily recognizable unit, as its members are characterized by a stout antenna, with most flagellomeres transverse to quadrate (except sometimes the first flagellomere slightly elongate), and relatively cubic head in dorsal view, with antenna on a high shield (Fig. 1A). All species close to *O. spurius* Gravenhorst, 1829 are placed in this group, which, in addition to the mentioned characters, always have a closed, sessile areolet in the fore wing (abscissa of Rs between 2rs-m and 3rs-m at least 0.6 × the length of 2rs-m) and the subocular sulcus often weakly defined or absent.

5. *Orthocentrus wahlbergi* species-group. Probably the most species-rich group in Europe, containing species with a papillate face (e.g. Figs 2D, 5C) and granulate second tergite of the metasoma (e.g. Figs 2F, 5D, E). All the species close to *O. asper* (Gravenhorst, 1829) should be placed in this morphological unit, including two revised in this study: *O. bilineator* and *O. hirsutor*.

The placing of the Western Palaearctic *Orthocentrus* species into groups proposed in the present paper is still very preliminary and should be tested with the aid of molecular data in future studies.

The present study is the first of a series aiming at revising the Western Palaearctic *Orthocentrus* by the first author. The main aim of the current paper is to resolve confusion with interpretation of *O. castellanus* and illustrate the rarely collected, but the most easily recognizable species of the genus, those having pale inner orbits extending onto the vertex.

Materials and methods

This study is based on specimens from the following collections:

CEUA Entomological Collection of the University of Alicante, Spain (Santiago Bordera)
FDG private collection of Filippo Di Giovanni, Siena (Filippo Di Giovanni)
LC private collection of Pierre-Nicolas Libert, Somal, Belgium (Pierre-Nicolas Libert)
MNCN National Museum of Natural Sciences, Madrid, Spain (Mercedes París)
MUST Museum Stavanger, Stavanger, Norway (Alf Tore Mjøs)
MZL Cantonal Museum of Zoology, Lausanne, Switzerland (Anne Freitag)
MZLU Zoologiska Institutionen, Lund, Sweden (Rune Bygebjerg)

NHRS Naturhistoriska Riksmuseet, Stockholm, Sweden (Hege Vårdal)
UwB Department of Biology, University of Białystok, Poland (Agata Kostro-Ambroziak)
RBINS Royal Belgian Institute of Natural Sciences, Bruxelles, Belgium (Fons Verheyde)
SIZK I. I. Schmalhausen Institute of Zoology, Kyiv, Ukraine (Oleksandr Varga)
SMTP Swedish Malaise Trap Project, Station Linné, Öland, Sweden (Dave Karlsson, Mårten Klinth)

Images of specimens were taken with a Leica Z16 APO microscope equipped with Leica FLEXACAM C1 camera and processed by LAS Core software (SIZK) and Olympus DSX110 opto-digital microscope (UwB). Morphological terminology follows Broad et al. (2018).

Taxonomy

Genus *Orthocentrus* Gravenhorst, 1829

Orthocentrus Gravenhorst, 1829: 358–359. Type species: *Orthocentrus anomalus* Gravenhorst, 1829, by subsequent designation in Westwood, 1840: 59.

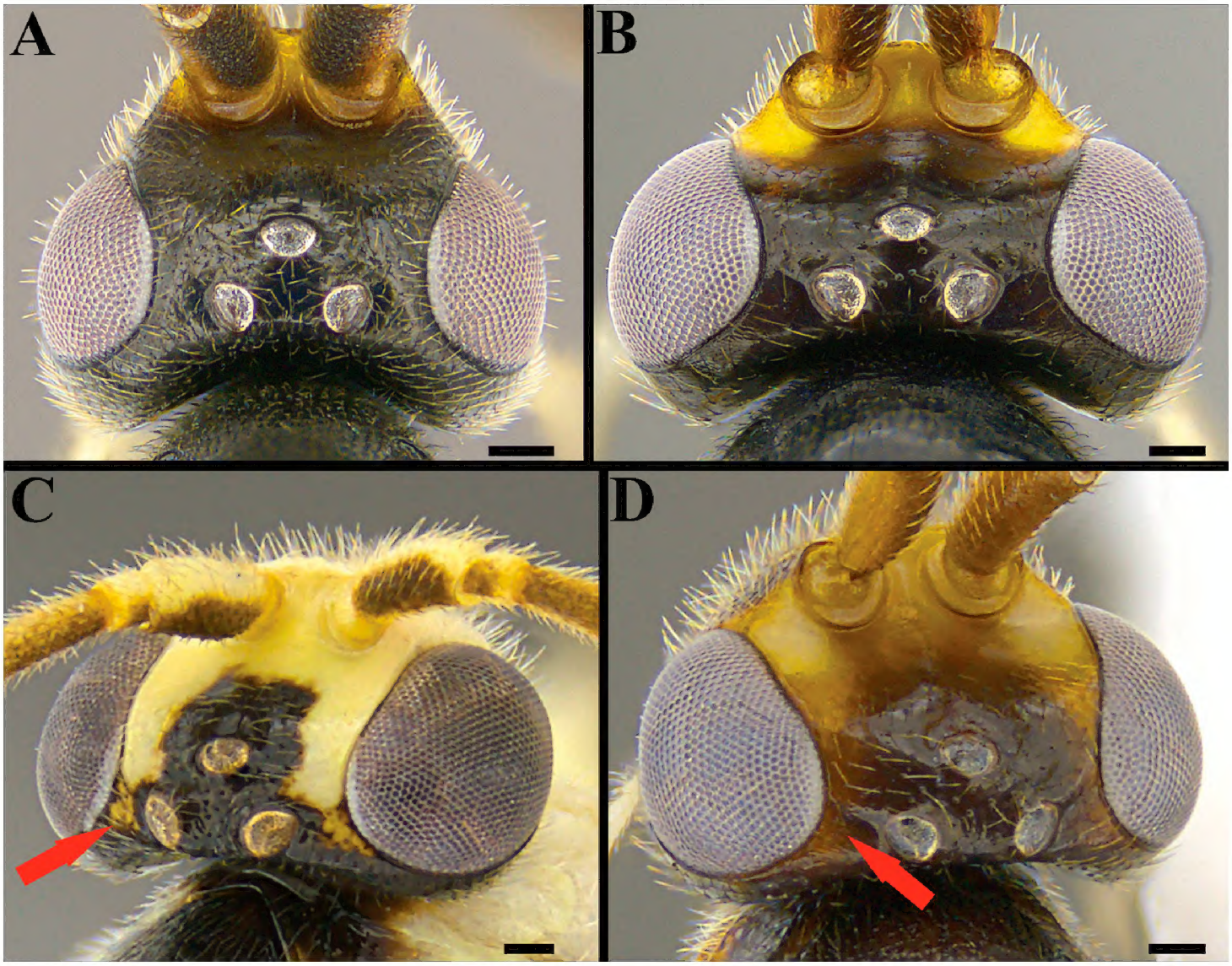

Figure 1. *Orthocentrus* spp., dorsal view of head **A** *O. fulvipes*, ♀ **B, D** *Orthocentrus* sp., ♀ **C** *Orthocentrus* sp., ♂. Traces of yellow colouration arrowed with red. Scale bar: 0.1 mm.

Diagnosis. The Western Palaearctic species are small to relatively large (fore wing 2–5 mm long) orthocentrines. Head in dorsal view strongly transverse to almost cubic (Fig. 1). Face densely punctate, papillate or aciculate on smooth or granulate background. Clypeus fused with face, forming uniformly convex surface; lower edge of clypeus usually rounded or rarely straight to weakly truncate; labrum usually hidden, but sometimes visible (Figs 2D, 3E, 4E, F, 5C, 6B, 7D, E). Scape usually long, subcylindrical. Mandibles usually bidentate, narrowed apically, lower tooth much shorter than upper tooth, visible in frontoventral view, but sometimes mandibles twisted, and thus lower tooth is vestigial and not visible. Subocular sulcus present to absent. Notauli present anteriorly or absent. Epicnemial carina present laterally and ventrally. Pleural carina present (Fig. 6C). Propodeum usually with lateral longitudinal, lateromedian longitudinal and posterior transverse carinae present (Fig. 6E). Fore wing with vein 3rs-m present or absent, areolet (if closed) sessile or petiolate, quadrate or pentagonal (Figs 2C, 3C, 5A, B, 6F). Hind wing with nervellus reclivous, inclivous or vertical, usually broken, but rarely second abscissa of Cu entirely absent. First metasomal tergite from smooth and shiny to granulate, wrinkled or rugose (Figs 2F, 3G, 4G, H, 5D, E, 6G, H, 7H, I). Ovipositor straight or upcurved, with or without dorsal subapical notch, at most 0.5 × the length of the hind tibia; ovipositor sheath setose except basally, parallel-sided to widened distally.

Key to females of Western Palaearctic species of *Orthocentrus* with ivory/yellow marks on the vertex

1 Head in dorsal view with yellow or ivory marks (evenly coloured along the entire length) on vertex often extending along the inner orbits to the antennal sockets (Figs 2E, 3F, 4D, 6D, 7F). In males, yellow always ends beyond the level of the lateral ocellus (Figs 4F, 5B, 7G) **2**

– Head in dorsal view without yellow or ivory marks on vertex (Fig. 1A, B), or at most with weak traces of yellow along inner orbits joining the distinct yellow frontal spots opposite the antennal sockets (Fig. 1D). Frons of male sometimes partly to entirely yellow, but pale markings end at most beyond the median ocellus (Fig. 1C) ..... **other species of *Orthocentrus***

2 Eye densely setose (Fig. 5C). Antenna with 33–35 flagellomeres. [First tergite with lateromedian longitudinal carinae present; second tergite with deep transverse furrow (Fig. 5D)] ..... ***O. hirsutor***

– Eye at most sparsely setose (Fig. 2D). Antenna with at most 29 flagellomeres... **3**

3 Tergites 1–4 longitudinally wrinkled on shiny background (Fig. 6H); first tergite with lateromedian longitudinal carinae strong (Fig. 6G). Face sparsely punctate and weakly granulate (Fig. 6B). Antenna with first flagellomere 3.0–3.1 × as long as wide (Fig. 6C) ..... ***O. mirabilis* sp. nov.**

– Tergites 1–3 granulate (e.g. Fig. 7H); first tergite with lateromedian longitudinal carinae weak to indistinct (Figs 2F, 3G, 4G, 7H). Face papillate or aciculate (Figs 2D, 3E, 4E, 7D). Antenna with first flagellomere at most 2.5 × as long as wide (Fig. 3F) **4**

4 Fore wing with areolet sessile (Fig. 2C). Face papillate (Fig. 2D). First tergite 1.4–1.5 × as long as posterior width, with lateromedian longitudinal carinae present; second tergite 0.8–1.0 × as long as posterior width; tergites 2–3 each with a strong subapical transverse furrow, granulate (Fig. 2F)..... ***O. bilineator***

– Fore wing with areolet petiolate (Figs 3C, 7A, B). Face aciculate (Figs 3E, 4E, 7D). First tergite 1.5–1.8 × as long as posterior width, with lateromedian longitudinal carinae weak to indistinct; second tergite 1.0–1.2 × as long as posterior width; third tergite without a subapical transverse furrow, granulate at most proximally (Figs 3G, 4G, 7H) **5**

5 Mesoscutum and scutellum orange, marked with yellow (Fig. 3A, B). Antenna with first flagellomere 2.5 × as long as wide (Fig. 3F). Frons entirely ivory except the interocellar area (Fig. 3F)..... ***O. canariensis***

– Mesoscutum and scutellum black (Figs 4A, 7A). Antenna with first flagellomere at most 2.4 × as long as wide (Fig. 4B). Frons brownish to black centrally (Fig. 4D, 7F) **6**

6 Antenna with 26–29 flagellomeres; first flagellomere 2.0–2.4 × as long as wide; median flagellomeres distinctly elongate (Fig. 4B). Pronotum in upper half largely yellow (Fig. 4A) ..... ***O. castellanus***

– Antenna with 24–26 flagellomeres; first flagellomere 1.6–1.7 × as long as wide; median flagellomeres subquadrate (Fig. 7C). Pronotum with narrow yellow/ivory line along upper margin (Fig. 7A)..... ***O. orbitator***

Orthocentrus bilineator Aubert, 1959

Fig. 2

Material examined. ***Holotype.*** **[France]** • ♀; Ville Amont (P.O) [Pyrénées-Orientales/Boule d'Amont]; 25 Aug. 1958, J. F. Aubert [? leg.]; *Orthocentrus bilineator* Type, J. F. Aubert det. [handwritten] // labelled as holotype by S. Klopfstein, 2009; GBIFCH 00908846; MZL.

Additional material. **Italy** • 11 ♀♀; Toscana, Is. Elba; 21 Sep.–23 Oct. 2001; Malaise trap; FDG, SIZK.

Diagnosis. Female. Face papillate; eye sparsely setose (Fig. 2D). Antenna with 27–28 flagellomeres, first flagellomere 1.4–1.5 × as long as wide (Fig. 2B). Vertex yellow along inner orbits. Mesosoma largely marked with orange and yellow, mesoscutum yellow/orange along notauli and on lateral margins and scutellum orange (Fig. 2E). Fore wing with vein 3rs-m present, areolet sessile (Fig. 2A); hind wing with nervellus intercepted below the middle (Fig. 2C). Metasomal tergites granulate, banded with yellow posteriorly (Fig. 2A, F); first tergite 1.4–1.5 × as long as posterior width, with latero-median longitudinal carinae present, but weak; second tergite 0.8–1.0 × as long as posterior width; tergites 2–3 each with a strong subapical transverse furrow, granulate (Fig. 2F).

Male. Unknown.

Distribution. Currently known only from the South of France (Aubert 1978) and Central Italy (first record). Possibly a Tyrrhenian species.

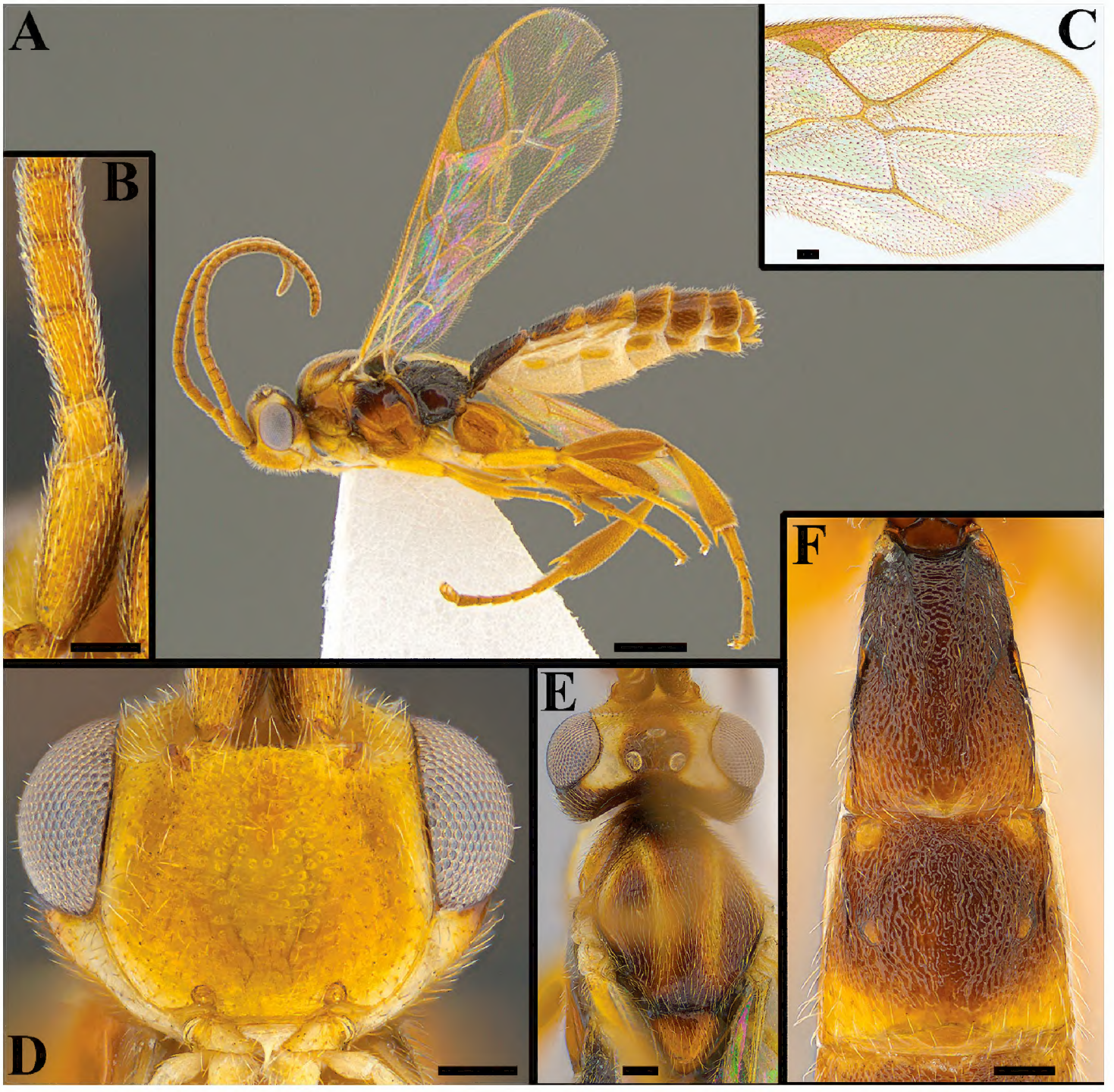

Figure 2. *Orthocentrus bilineator*, ♀ **A** lateral view of habitus **B** frontal view of base of antenna **C** areolet **D** frontal view of face **E** dorsal view of head and mesoscutum **F** dorsal view of metasomal tergites 1–2. Scale bars: 0.5 mm (**A**); 0.1 mm (**B–F**).

Remark. The holotype specimen is generally more robust, with the first tergite 1.4 × and second tergite 0.8 × as long as the posterior width. The Italian specimens are slenderer, but otherwise are the same as the holotype.

Orthocentrus canariensis Hellén, 1949

Fig. 3

Material examined. ***Paratype.*** **[Spain]** • ♀; Canary Islands, Tenerife, Agua Garcia; R. Frey [? leg.]; labelled as paratype by J. Aubert; 4994; GBIFCH 00894863; MZL.

Diagnosis. Female. Face aciculate in upper half, shiny; eye glabrous (Fig. 3E). Antenna with 26 flagellomeres, first flagellomere 2.5 × as long as wide (Fig. 3F). Frons entirely ivory

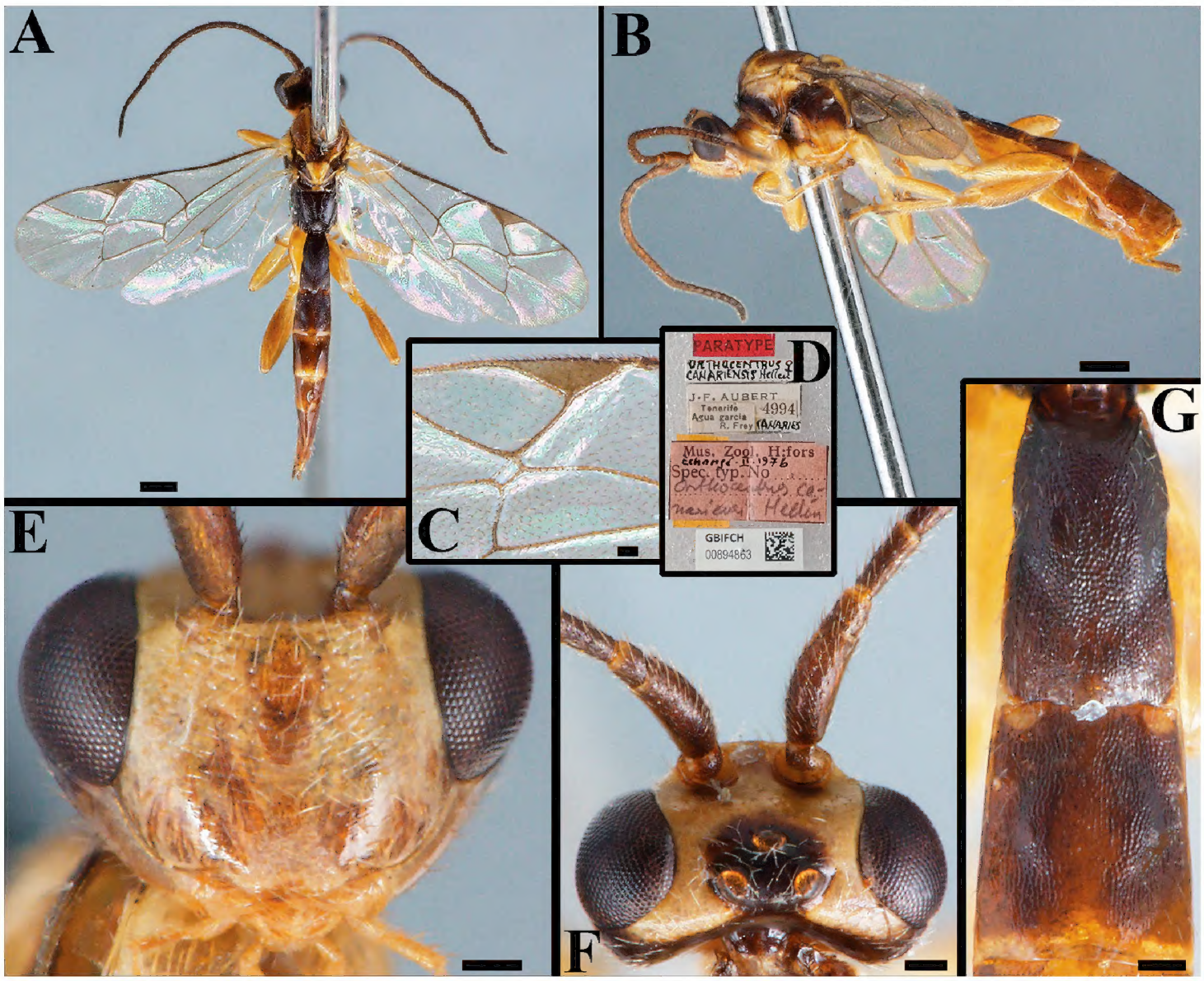

Figure 3. *Orthocentrus canariensis*, paratype ♀ **A** dorsal view of habitus **B** lateral view of habitus **C** areolet **D** labels **E** frontal view of face **F** dorsal view of head **G** dorsal view of metasomal tergites 1–2. Scale bars: 0.5 mm (**A, B**); 0.1 mm (**C–G**).

except for interocellar area (Fig. 3F). Mesosoma largely marked with orange and yellow; mesoscutum and scutellum orange, yellow along notauli and on lateral margins (Fig. 3A, B). Fore wing with vein 3rs-m present, but partly unpigmented, areolet petiolate (Fig. 3C); hind wing with nervellus intercepted below the middle (Fig. 3A). First metasomal tergite 1.8 × as long as posterior width, weakly granulate, with lateromedian longitudinal carinae indistinct; second tergite 1.2 × as long as posterior width, with a weak subapical transverse furrow, weakly granulate; third tergite weakly granulate on anterior 0.2 (Fig. 3A, G).

Male. Unknown.

Distribution. Spain: currently known from two localities on Tenerife (Hellén 1949).

Orthocentrus castellanus Ceballos, 1963

Fig. 4

Material examined. ***Lectotype.*** **[Spain]** • 1 ♀; La Granja [Real Sitio de San Ildefonso, Segovia]; Sep. 1933; J. Gil [J. Gil Collado leg.]; *Orthocentrus castilianus* Tipo [Type], G. Ceballos det. [handwritten by Ceballos] // Según Dr. Aubert de 1972 es válida la identificación

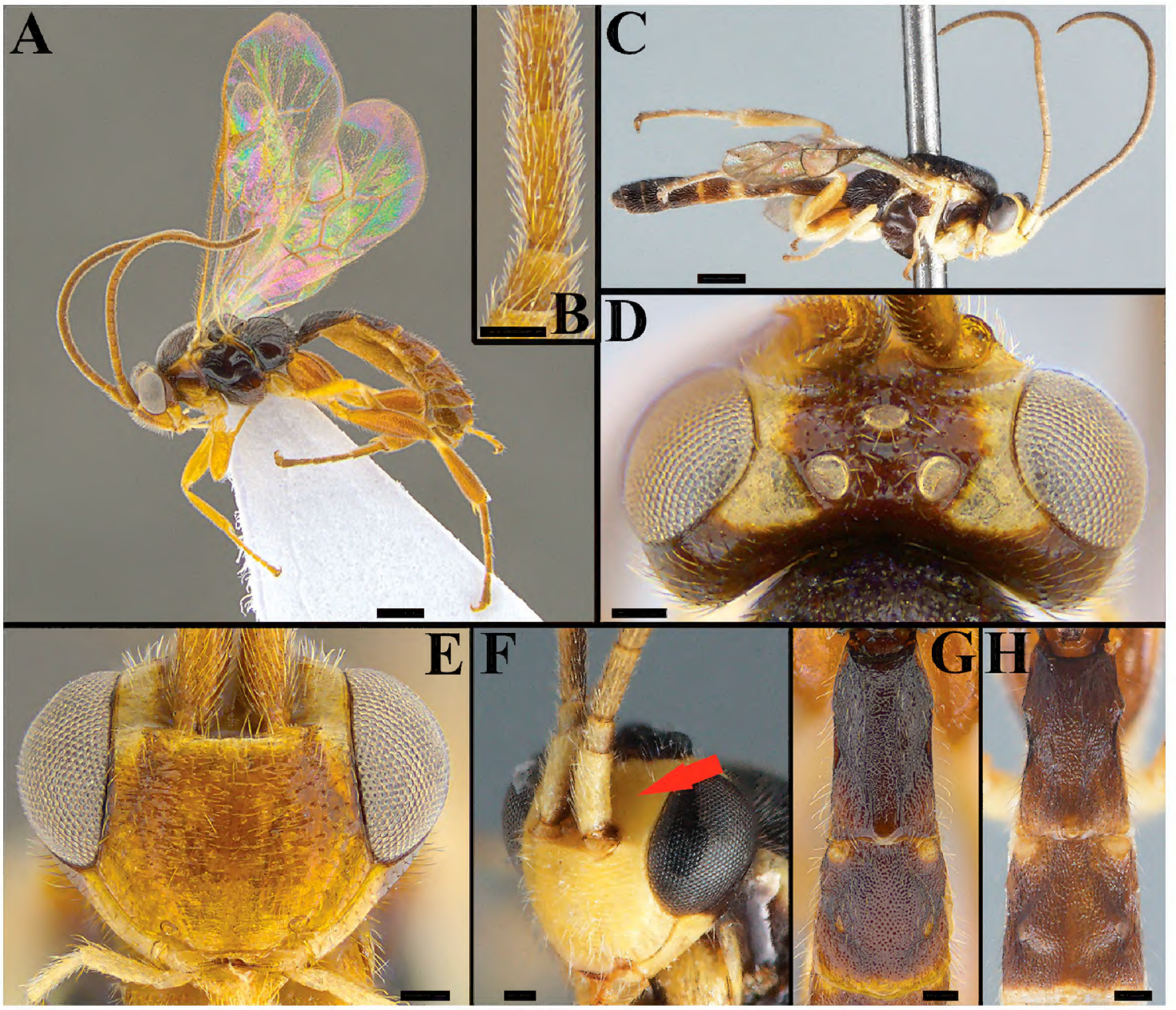

Figure 4. *Orthocentrus castellanus* **A, B, D, E, G** ♀ **C, F, H** ♂ **A, C** lateral view of habitus **B** frontal view of base of antenna **C** areolet **D** dorsal view of head **E** frontal view of face **F** dorsolateral view of head. Yellow frons arrowed with red **G, H** dorsal view of metasomal tergites 1–2. Scale bars: 0.5 mm (**A, C**); 0.1 mm (**B, D–H**).

de «castillanus Ceb.» [After Dr. Aubert in 1972 the identification «castillanus Ceb.» is correct; probably handwritten by I. Izquierdo] // *Orthocenthrus castellanus* Ceb. Lectotipo [= Lectotype] C. Rey desig.[nated in] 1990 // *Orthocentrus corrugatus* Holm. (= *castilianus* Ceb.) JF Aubert det.; MNCN Cat. Tipos Nº 9217; MNCN_Ent 392296; MNCN. ***Paralectotype.*** **[Spain]**: • 1 ♀; La Granja [Real Sitio de San Ildefonso, Segovia]; July 1934; Gil Collado [J. Gil Collado leg.]; *Orthocentrus castilianus* G. Ceballos det. [handwritten by Ceballos] // Paralectotipo [= Paralectotype, prob. added by C. Rey after the designation of the other syntype as lectotype]; MNCN Cat. Tipos Nº 9217; MNCN_Ent 392297; MNCN.

Additional material. Cyprus • 1 ♂; Kakopetria; 10 May 1978; J. F. Aubert leg.; GBIFCH 00909028; MZL. **[France]** • 1 ♀; Les Grillons (BA) [Basses-Alpes]; 06 July 1967; J. F. Aubert leg.; GBIFCH 00991635; MZL. **Italy** • 1 ♀; Toscana, Is. Elba; 02–15 May 2001; Malaise trap; FDG.

Diagnosis. Female. Face aciculate; eye glabrous (Fig. 4E). Antenna with 26–29 flagellomeres, first flagellomere 2.0–2.4 × as long as wide (Fig. 4B). Vertex yellow

or ivory along inner orbits (Fig. 4D). Mesosoma black, with only propleuron and pronotum largely marked with yellow (Fig. 4A). Fore wing with vein 3rs-m present, areolet petiolate; hind wing with nervellus intercepted below the middle (Fig. 4A). First metasomal tergite 1.7–1.8 × as long as posterior width, weakly granulate, with latero-median longitudinal carinae weak to indistinct; second tergite 1.1 × as long as posterior width, with a weak subapical transverse furrow, weakly granulate (Fig. 4G); third tergite weakly granulate on anterior 0.4.

Male. See remark.

Distribution. Spain, France (Aubert 1978), ? Bulgaria (Kolarov 1986), Iran (Mohammadi-Khoramabadi and Talebi 2013), ? Cyprus (see remark), first record for Italy.

Remark. The head of the paralectotype female is missing and the specimen has pronotum with a yellow line along upper margin, thus it probably belongs to *O. orbitator*. The single male from Cyprus identified by J. Aubert as questionable was examined. The specimen generally resembles females (Fig. 4C, F, H), but has shorter antenna with 25 flagellomeres (first flagellomere 3.0 × as long as wide) and an entirely yellow frons (Fig. 4F). The specimen differs from males of *O. orbitator* only by the more abundant yellow on the frons (to compare see Fig. 7G), while the number and length of the flagellomeres are the same. Thus, the status of the specimen remains uncertain until freshly collected specimens associated with females or confirmed by molecular markers can be studied and described.

Orthocentrus hirsutor Aubert, 1969

Fig. 5

Material examined. ***Holotype.*** **[France]** • 1 ♀; Corse/Val de Furani [Korsika; Furiani-Tal; Kulturland]; 250 m a.s.l.; 04 May 1964; Diller leg.; *Orthocentrus hirsutor* Type, J. F. Aubert det. [handwritten] // labelled as holotype by S. Klopfstein, 2009; GBIFCH 00908839; MZL. ***Paratype.*** Swisse **[Switzerland]** • 1 ♂; Neuchâtel, Montmollin; 14 Aug. 1962; J. de Beaumont [leg.]; *Orthocentrus hirsutor* Type, J. F. Aubert det. [handwritten] // labelled as paratype by S. Klopfstein, 2009; GBIFCH 00909339; MZL.

Additional material. **Italy** • 3 ♂♂; Piemonte, CN, Roddi, loc. Ravinali; 18 May–06 June 2016; Loni-Scaramozzino leg.; TM 4; FDG; • 1 ♂; idem, but 06–29 June 2016; FDG; • 2 ♀♀; La Morra, loc. Cerequio; 07–30 Sep. 2016; Loni-Scaramozzino leg.; TM3; FDG. **Sweden** • 1 ♀; Bl, Ronneby kommun, Tromtö nabb.; 56.149067, 15.480017 (=TrapID 23); 12–27 Aug. 2004 (=coll. event ID 1013); Swedish Malaise Trap Project leg.; beech and oak forest; SMTP; • 1 ♀; idem, but 25 Aug.–08 Sep. 2005 (=coll. event ID 1413); SMTP. **Ukraine** • 2 ♂♂, 3 ♀♀; Ivano-Frankivsk Region, Dibrova; 48.772645, 24.508804; 310 m a.s.l.; 22–23 May 2023; O. Varga leg.; oak forest; SIZK; • 1 ♀; Mochary, 5 km NE of Bogorodchany; 48.8371 N, 24.5814 E; 315 m a.s.l.; 19 July 2012; O. Varga leg.; sweeping, mixed forest; SIZK; • 1 ♀; idem, but 01–18 May 2018; O. Varga leg.; Malaise trap №5; SIZK; • 2 ♂♂, 1 ♀; idem, but 12 May 2023; O. Varga leg.; sweeping; SIZK; • 3 ♂♂; Zhbyr; 48.775618 N, 24.481181 E; 08

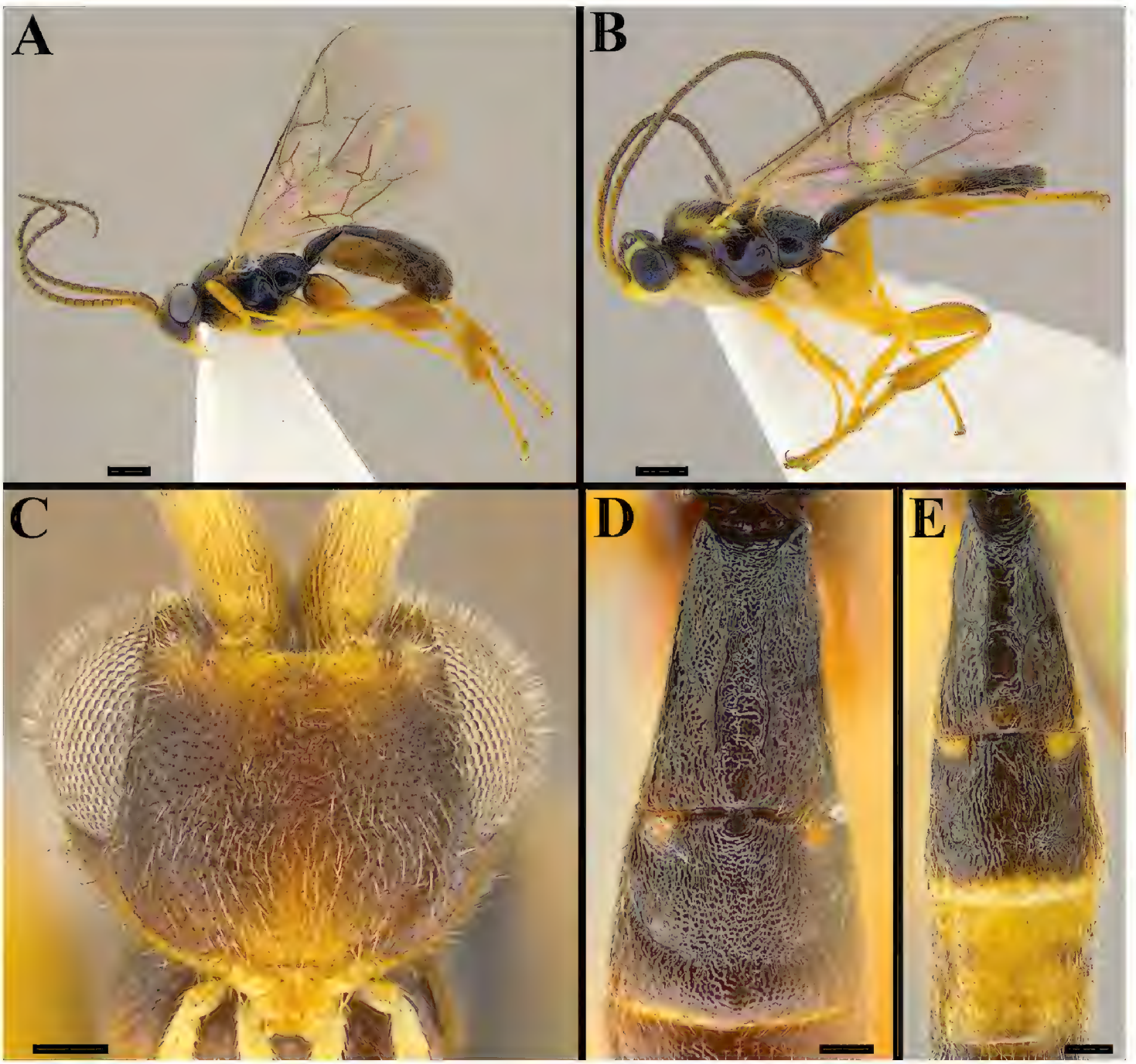

Figure 5. *Orthocentrus hirsutor* **A, C, D** ♀ **B, E** ♂ **A, B** lateral view of habitus **C** frontal view of face **D** dorsal view of metasomal tergites 1–2 **E** dorsal view of metasomal tergites 1–3. Scale bars: 0.5 mm (**A, B**); 0.1 mm (**C–E**).

June 2022; O. Varga leg.; sweeping, mixed forest; SIZK; • 1 ♀; Zahvizdya; 48.94340, 24.62228; 10 Oct. 2024; O. Varga leg.; sweeping, deciduous forest; SIZK; • 1 ♀; Gorgany, m. Igrovets; 48.598605 N, 24.131280 E; 1375 m; 02–20 July 2014; O. Varga leg.; Malaise trap №3; SIZK; • 1 ♀; Transcarpathian Region, Vynogradiv; 48.138338 N, 23.073689 E; 07 June–03 July 2018; O. Varga leg.; Malaise trap №2, beech forest; SIZK; • 1 ♀; Svydovets, 2–3 km NW of Kvasy; 48.1447 N, 24.2708 E; 750 m a.s.l.; 05–29 June 2014; O. Varga leg.; Malaise trap, beech forest; SIZK; • 1 ♀; idem, but 29 June–15 July 2014; SIZK; • 4 ♀♀; idem, but 10 Aug.–01 Sep. 2014; SIZK.

Diagnosis. Female. Face densely papillate; eye densely setose (Fig. 5C). Antenna with 33–35 flagellomeres, first flagellomere 1.0–1.1 × as long as wide. Vertex with yellow along inner orbits. Mesosoma black; mesoscutum sometimes with yellow lines along notauli. Fore wing with vein 3rs-m present, areolet sessile; hind wing with

nervellus intercepted below the middle (Fig. 5A, B). First metasomal tergite 1.5 × as long as posterior width, granulate, with lateromedian longitudinal carinae strong; second tergite 0.9–1.0 × as long as posterior width, with a strong subapical transverse furrow, granulate (Fig. 5D); third tergite weakly granulate.

Male. Generally resembles female, but has more abundant yellow on the head, pronotum and mesoscutum (Fig. 5B); shorter antenna, with 26–27 flagellomeres (first flagellomere 1.6–1.7 × as long as wide) and almost entirely yellow third tergite (Fig. 5E).

Distribution. Palaearctic (Yu et al. 2016; Humala et al. 2020), first records for Italy, Sweden and Ukraine.

Remark. The hind coxa and femur vary from red to brown. The frons sometimes black with inner orbits yellow only on the vertex.

Orthocentrus mirabilis Varga & Di Giovanni, sp. nov.

https://zoobank.org/C88F1FBD-1F27-47C5-81A3-AD04D79C940C

Fig. 6

Material examined. ***Holotype.*** **Ukraine** • ♀; Ivano-Frankivsk Region, Mochary, 5 km NE of Bogorodchany; 48.8371 N, 24.5814 E; 315 m a.s.l.; 09 Apr. 2024; O. Varga leg.; mixed forest, sweeping; SIZK. ***Paratypes.*** **Belgium** • 1 ♀; Waals-Brabant, Ottignies; 03–10. Sep. 1982; P. Dessart leg.; Malaise trap; RBINS; • 1 ♀; Somal, fauché, chemin humide en friche, reboisement en cours [sweeped with net, fallow wet path, reforestation in progress]; 27 Nov. 2013; P.-N. Liebert leg.; LC; • 1 ♀; Ieper, De Triangel; 50.8427, 2.8840; 14–28 May 2022; F. Verheyde leg.; Malaise trap B; RBINS; • 1 ♀; idem, but 23 July–06 Aug. 2022; RBINS. **Italy** • 1 ♀; Veneto – TV, Cessalto – Bosco Olmè; 45°41'57.42"N, 12°37'4.92"E; 23 July–05 Aug. 2013; F. Di Giovanni leg.; Malaise trap 213; FDG; • 1 ♀; Gaiarine, loc. Produttiva Francenigo, Bosco Otello; 45°51'36.96"N, 12°29'28.08"E; 23 July–05 Aug. 2013; F. Di Giovanni leg.; Malaise trap; FDG; • 1 ♀; Friuli-Venezia Giulia – UD, Precenicco – Bosco Bando; 45°46'37.32"N, 13°3'50.04"E; 08–18 May 2013; F. Di Giovanni leg.; Malaise trap 179; FDG; • 1 ♀; Piemonte – CN, Roddi, loc. Ravinali; 09 Aug.–09 Sep. 2016; Loni-Scaramozzino leg.; TM 4; SIZK. • 1 ♀; Emilia-Romagna – BO, Sasso Marconi, Palazzo Rossi; 08 Mar. 2010; L. Colacurcio leg.; FDG. **Poland** • 1 ♀; Podlaskie Voivodeship, Biebrza National Park, Grobla Honczarowska, mineral island Pogorzały; 21 Sep. 2006; A. Kostro-Ambroziak leg.; oak-linden-hornbeam forest, birch with alder, yellow pan trap «c»; SIZK. **Sweden** • 1 ♀; Bl, Ronneby kommun, Tromtö nabb.; 56.149067, 15.480017 (=TrapID 23); 12–27 Aug. 2004 (=coll. event ID 1013); Swedish Malaise Trap Project leg.; beech and oak forest; NHRS-HEVA000025137; NHRS; • 2 ♀♀; Up, Håbo kommun, Biskops-Arnö, northern beach; 59.672133, 17.500850 (=Trap ID 8); 27 Aug.–10 Sep. 2004 (=coll. event ID 1562); Swedish Malaise Trap Project leg.; elm grove; NHRS-HEVA000025138, NHRS-HEVA000025139; NHRS; • 1 ♀; Uppsala kommun, Ekdalens naturreservat; 59.971517, 18.354983 (=Trap ID 27); 07–21 July 2003 (=coll. event ID 466); Swedish Malaise Trap Project leg.; tall herbs

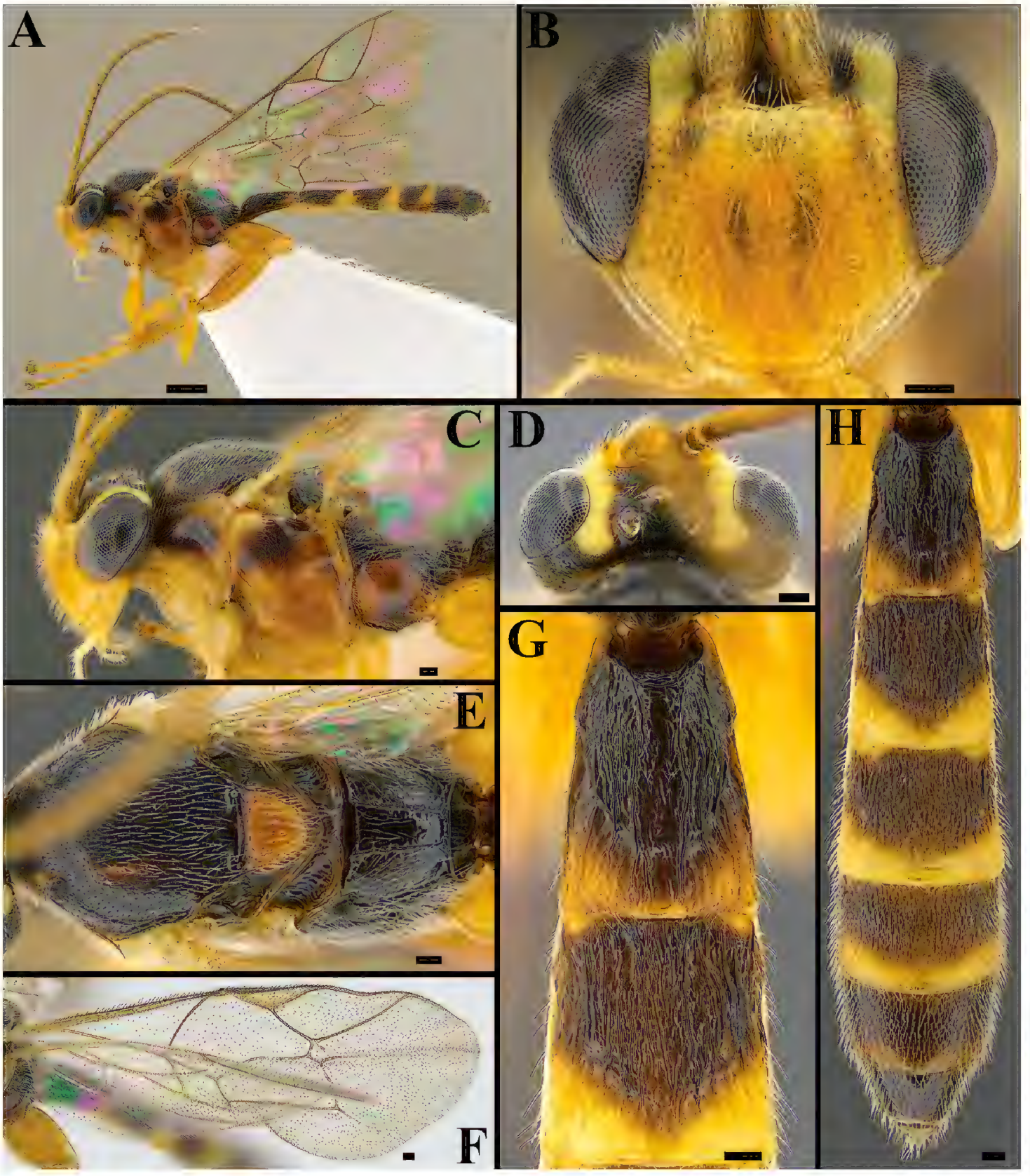

Figure 6. *Orthocentrus mirabilis* sp. nov., holotype ♀ **A** lateral view of habitus **B** frontal view of face **C** lateral view of head and mesosoma **D** dorsal view of head **E** dorsal view of mesosoma **F** wings **G** dorsal view of metasomal tergites 1–2 **H** dorsal view of metasoma. Scale bars: 0.5 mm (**A**); 0.1 mm (**B–H**).

and young trees mixed with old oaks; NHRS-HEVA000025140; NHRS; • 1 ♀; Ög, Ödeshögs kommun, Omberg, Bokskogsreservatet; 58.297183, 14.634817 (=Trap ID 16); 08 Aug.–08 Sep. 2004 (=coll. event ID 962); Swedish Malaise Trap Project leg.; beech forest; NHRS-HEVA000025141; NHRS.

Diagnosis. *Orthocentrus mirabilis* sp. nov. is characterized by the combination of the following: face sparsely punctate, with traces of granulation; eye glabrous (Fig. 6B);

antenna with 26–27 flagellomeres, first flagellomere 3.0–3.1 × as long as wide (Fig. 6C); vertex yellow along inner orbits (Fig. 6D); mesosoma largely marked with orange and yellow, scutellum orange (Fig. 6C, E); fore wing with vein 3rs-m present, areolet petiolate; hind wing with nervellus intercepted below the middle (Fig. 6F); metasomal tergites strongly longitudinally wrinkled on smooth and shiny background, banded with yellow posteriorly (Fig. 6G, H); first tergite 1.4–1.5 × as long as posterior width, with lateromedian longitudinal carinae strong; second tergite 1.0–1.1 × as long as posterior width, with deep transverse furrow (Fig. 6G).

Orthocentrus mirabilis sp. nov. differs from all known Western Palaearctic species with a yellow vertex by the strongly longitudinally wrinkled metasoma. *Orthocentrus mirabilis* sp. nov. is similar to the Korean *O. flavescens* Humala & Lee, 2020, but differs by the longer antenna with 26–27 flagellomeres (20 in *O. flavescens*) and the fore wing with vein *3rs-m* present (absent in *O. flavescens*).

Description. Female. Holotype. Body length 5 mm. Fore wing 3.5 mm.

Head weakly sculptured and densely pubescent. Antenna with 27 flagellomeres, first flagellomere 3.1 × as long as wide. Face about 0.7 × as long as wide, sparsely punctate, weakly granulate between punctures, sparsely pubescent; inner orbits divergent ventrally. Malar space 3.3 × basal width of mandible; subocular sulcus distinct. Clypeus 0.5 × as long as wide, fused with face, apical margin weakly truncate. Mandible strongly bent outward, lower tooth not visible due to mandible position. Temples strongly narrowed in dorsal view; head 1.9 × as wide as high in dorsal view. Frons and vertex weakly granulate; length of ocellar-ocular distance about 1.0 × maximum diameter of lateral ocellus; occipital carina absent.

Propleuron densely pubescent. Pronotum smooth; epomia absent. Mesoscutum densely pubescent; notauli deep anteriorly; scutellum densely pubescent. Mesopleuron smooth and densely pubescent on anterior half; epicnemial carina present ventrally and laterally, reaching anterior margin of mesopleuron. Metapleuron smooth, densely pubescent along margins; pleural and submetapleural carinae present. Propodeum smooth, with lateral longitudinal, lateromedian longitudinal and posterior transverse carinae present.

Legs relatively stout; hind femur 3.1 × as long as wide, third tarsomere of hind tarsus about 0.8 × as long as fifth tarsomere; tarsal claws simple.

Fore wing with vein 2rs-m about 1.0 × distance between 2rs-m and 2m-cu; vein 3rs-m present, partly unpigmented; vein 1cu-a weakly distal to M&Rs; hind wing with nervellus intercepted below middle, more or less vertical, distal abscissa of Cu largely unpigmented.

First metasomal tergite 1.5 × as long as posterior width, longitudinally wrinkled, smooth and shiny; latero-median longitudinal carinae strong; lateral oblique grooves present. Second tergite 1.1 × as long as posterior width, longitudinally wrinkled, with deep transverse furrow; thyridium small. Tergites 3–4 same structure and sculpture as previous tergite. Fifth tergite more weakly sculptured on anterior 0.8, with transverse furrow absent. Sixth tergite densely pubescent and smooth. Ovipositor very short, not strongly projecting beyond apex of metasoma, its sheath slightly widened and pubescent.

Colour. Head largely yellow except antenna, frons, vertex and gena partly black. Mesosoma black except propleuron and pronotum largely yellow, meso- and

metapleuron largely orange and yellow, mesoscutum with narrow orange stripes, scutellum orange. Fore and mid coxae, trochanters and trochantelli yellow, fore and mid femora, tibiae and tarsi orange; hind legs orange except trochanters and trochantelli, tibia basally and tarsomeres largely yellow. Metasoma black except tergites 1–5 posteriorly banded with yellow.

Male. Unknown.

Etymology. The new species is named after the relatively colourful body in comparison to the other European species of the genus. Adjective.

Distribution. Currently known from Belgium, Italy, Poland, Sweden, Ukraine (this study), and erroneously reported as *O. castellanus* from UK (Galsworthy 2022), ? Germany (Riedel et al. 2021), and ? South Korea (Humala et al. 2020) (see Discussion).

Remark. The colour of the mesosoma varies from largely yellow and orange ventrally and on the mesoscutum to black with only some yellow marks on the pronotum and mesopleuron, but the scutellum is always orange or brownish, and thus at least slightly paler than mesoscutum.

Orthocentrus orbitator Aubert, 1963

Fig. 7

Material examined. ***Paratype.*** **[France]** • ♀ Pampelonne, Var; 01–07 Aug. 1963; *Orthocentrus orbitator*, J. F. Aubert det. [handwritten] // paratype [red printed label]; MZLU-HYM00065379; MZLU. ***Syntypes.*** **[France]** • 2 ♀♀ (pinned on the same pin); Pampelonne, Var; 02 Aug. 1963; *Orthocentrus orbitator* Type, J. F. Aubert det. [handwritten] // type [red printed label] // labelled as syntypes 27 & 28/52(42) by S. Klopfstein, 2009; GBIFCH 00905806; MZL.

Additional material. **Israel** • 1 ♀; Haifa; 21 July 2006; S. Simutnik leg.; SIZK. **Italy** • 1 ♀; Toscana, Is. Elba; 21 Sep.–23 Oct. 2001; Malaise trap; FDG; • 1 ♀; Toscana, Siena; 23–26 Oct. 2012; pan trap DI 34/4; FDG; • 1 ♂; Sicilia, Catania, Monte Etna, Tremestieri Etneo; 25 Mar. 1993; G. Turrisi leg.; FDG. **Norway** • 1 ♂, 1 ♀; TRY, Senja, Storholtet; 69.18868 N, 17.37885 E; 07 July–07 Aug. 2023; I. Birkeland leg; Malaise trap; SIZK; 1 ♀; Gammelsætra; 69.17051N, 17.38051E; 1–31 July 2023; I. Birkeland leg.; Malaise trap; SIZK; 1 ♀; Første Velta; 69.20305N, 17.38824E; 1–31 Aug. 2023; I. Birkeland leg; Malaise trap; SIZK. **Spain** • 2 ♂♂; P. N. Cabañeros (C. Real), Viñuelas; 26 Mar.–14 Apr. 2004; CIBIO leg.; Matorral [area with shrubs], TMo1; CEUA; • 1 ♀; idem, but 14 Apr.–08 May 2004; CEUA; • 1 ♀; Gargantilla; 19 Mar.–13 Apr. 2005; CIBIO leg.; Fresneda [*Fraxinus* forest], TM 2; CEUA. **Turkey** • 1 ♂; Isparta, Gelincik Dağı (IV. Bölge); 03 July 2010; Malaise trap; SIZK. **Ukraine** • 1 ♀; Transcarpathian Region, Svydovets, 2–3 km NW of Kvasy; 48.1447 N, 24.2708 E; 750 m a.s.l.; 10 Aug.–01 Sep. 2014; O. Varga leg.; trunk trap on dead *Fagus sylvatica*, beech forest; SIZK.

Diagnosis. Female. Face aciculate; eye glabrous (Fig. 7D). Antenna with 24–26 flagellomeres, first flagellomere 1.6–1.7 × as long as wide (Fig. 7C).

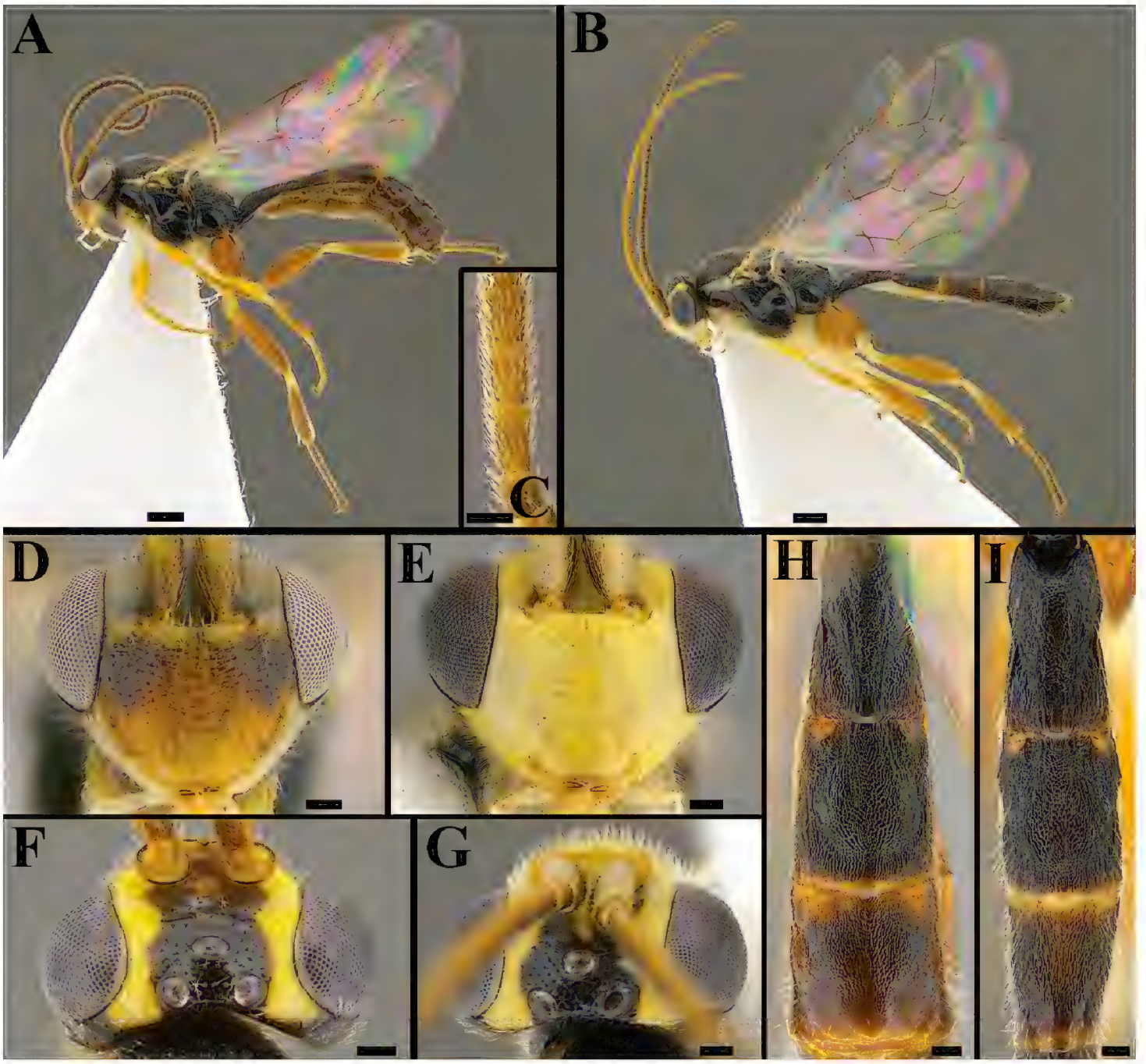

Figure 7. *Orthocentrus orbitator* **A, C, D, F, H** ♀ **B, E, G, I** ♂ **A, B** lateral view of habitus **C** frontal view of base of antenna **D, E** frontal view of face **F, G** dorsal view of head **H, I** dorsal view of metasomal tergites 1–3. Scale bars: 0.5 mm (**C–I**); 0.1 mm (**C–I**).

Vertex yellow or ivory along inner orbits (Fig. 7D, F). Mesosoma black except narrowly yellow on propleuron, and along upper and lower margins of pronotum (Fig. 7A). Fore wing with vein 3rs-m present, areolet petiolate; hind wing with nervellus intercepted below the middle (Fig. 7A). First metasomal tergite 1.5–1.6 × as long as posterior width, granulate, with lateromedian carinae weak to indistinct; second tergite 1.2 × as long as posterior width, with a weak subapical transverse furrow, granulate (Fig.); third tergite weakly granulate on anterior 0.5.

Male. Resembles female, but has more abundant yellow on the head, pronotum and mesoscutum; shorter antenna with 24–27 flagellomeres with the first flagellomere 3.0–3.1 × as long as wide (Fig. 7B, E, G, I).

Distribution. Western Palaearctic (Yu et al. 2016), first records for Israel, Italy, Turkey, and Ukraine.

Discussion

The Western Palaearctic *Orthocentrus* species revised in the current paper, that is, those having pale inner orbits extending onto the vertex, are rarely collected, but are the most easily recognised species of the genus. Four of the six studied species illustrated in this study, namely *O. canariensis*, *O. castellanus*, *O. mirabilis* sp. nov., and *O. orbitator*, belong to the same morphological unit comprising species with anteriorly distinct notauli, aciculate face, elongate basal flagellomeres, a strongly transverse head in dorsal view, and a closed areolet (most likely referring to the *Orthocentrus montanus* species-group sensu Humala (2019)). Among them, the largest difficulties with species interpretation are those relating to the identity of *O. castellanus*. Aubert originally (e.g. 1965, 1969) erroneously reported this species from France as *O. corrugatus* Holmgren, 1858, as indicated on his early identification labels, but he later considered *O. castellanus* as the valid name (Aubert 1978). Based on the species identification published in Galsworthy (2022) and Italian specimens preliminarily identified by A. Humala in 2015, it is clear that the latter author erroneously interpreted the species with longitudinally wrinkled and widely yellow-banded metasoma as *O. castellanus*, whereas this species is in fact *O. mirabilis* sp. nov. Thus, it is most likely that the records of *O. castellanus* from Germany (Riedel et al. 2021) and South Korea (Humala et al. 2020) are also referable to the newly described species. In fact, records reported in this paper based on examined specimens from Spain, France, and Italy represent the true *O. castellanus*. The Iranian record of this species also seems to be correct, based on Fig. 3 in Mohammadi-Khoramabadi and Talebi (2013), while the Bulgarian record (Kolarov 1986) remains uncertain due to the unavailability of specimens to examine.

Nevertheless, *Orthocentrus castellanus* and *O. orbitator* still remain two closely related species of unclear taxonomic status, as both species can be differentiated only on the basis of the length of the antennal flagellomeres and minor differences in the colouration of the pronotum. Females of both species share the same colour pattern: head with yellow/ivory orbital stripes extending beyond the lateral ocellus, fore and mid coxae, trochanters and trochantelli ivory, contrasting with largely red to slightly brownish hind legs (except that the hind tibia is ivory basally), while the pronotum, is variable in colour. Specimens of *O. orbitator* have a clearly defined yellow stripe usually extending along the entire upper margin of the pronotum (or at least for 2/3 of the length), while specimens of *O. castellanus* are characterized by a widely yellow upper hind corner of the pronotum. Unfortunately, both species are relatively rarely collected (only three specimens of *O. castellanus* were found among tens of thousands of *Orthocentrus* specimens examined), which makes it difficult to study the variability of characters considered crucial for their distinction, such as the length of the basal flagellomeres.

The same applies to at least two other species within the same complex, *O. marginatus* Holmgren, 1858 and another as yet undescribed species, both of which share the same head structure and a similar colour pattern to the aforementioned *O. orbitator* and *O. castellanus*. These species usually have the orbits black with only large yellow marks opposite the antennal sockets, but some specimens have a tendency to form faintly coloured yel-

low orbital stripes in both females (Fig. 1D) and males (Fig. 1C). However, such stripes are never evenly coloured along the entire length in females and are blurred opposite the lateral ocellus in males. In addition, the colouration of the pronotum is reduced to a small yellow mark in its upper hind corner, never extending along its entire upper margin. Males of all these four species still cannot be reliably identified except by being collected in association with females in large series. Molecular markers are certainly necessary to clarify the taxonomic status of these closely related species and will be applied in future studies when freshly collected specimens of both sexes become available to the authors.

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